

## Species composition, abundance and distribution of butterflies in a home garden habitat located at Hanguranketha, Nuwara Eliya district, Sri Lanka

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**Abstract:** The species richness, abundance and distribution of butterflies associated with a home garden, which was comprised of three micro-habitats; a grassland [GL], shrubland [SL] and disturbed-forest [DF], at Hanguranketha region, Nuwara Eliya district, was determined for a period of four months from September to December 2021, using a visual encounter survey. At each habitat, a belt transect (100 m x 10 m) was set up, and weekly observations were made within 20 minutes in the morning and the afternoon. Species diversity and the evenness were estimated using the Shannon-Weiner diversity index. A total of 32 species representing five families, Hesperidae, Lycaenidae, Nymphalidae, Papilionidae and Pieridae were encountered. Two species were reported as endangered, while 10 were endemic sub-species. These families were observed in all the three habitats, with the exception of Papilionidae in the GL. Nymphalidae was the most diverse family in DF (35 %) and SL (48 %) whereas Lycaenidae and Nymphalidae made up the most diversity in the GL (37 %). The DF harbored the highest species richness (88 %) and GL had the lowest (34 %). Altogether, 873 individuals were detected over four months. The abundance was found to be similar ( $P>0.05$ ) in the DF and SL, but lower ( $P<0.05$ ) in the grassland compared to the other two habitats. The maximum relative abundance was detected (61 %) in the Nymphalidae, while Hesperidae showed the second highest abundance. The highest diversity ( $H=2.91$ ) was recorded in the DF with 0.876 in evenness. Butterfly counts in the morning hours outnumbered the evening hours ( $P<0.05$ ). A reduction in butterfly counts ( $P<0.05$ ) was detected during November and December. The findings of this study revealed that this home garden is rich in butterflies and proper conservation mechanisms are essentially needed to protect them.

**Keywords:** *Species richness, abundance, butterflies, diversity, habitats, species richness*

### 1. INTRODUCTION

Butterflies (Superfamily Papilionoidea) belonging to order Lepidoptera, class Insecta, are one of the most colourful organisms with a great aesthetic value (Silva *et al.*, 2021). They play a vital ecological role not only as pollinators (Culliney & Pimentel, 1986) but also as major components in food chains (Tati-Subahar *et al.*, 2007). Butterflies show a great habitat preference and their species composition, abundance and distribution are negatively affected by the habitat variations and disturbances as well as climate changes. Hence, they serve as an excellent bio-indicators in terrestrial ecosystems (Haneda & Panggabean, 2019). Sri Lanka is one of the famous biodiversity hotspots in the world with a great diversity of butterflies (Van der Poorten G., 2012). Van der Poorten and Van der Poorten (2016) reported that the variable topography,

favorable climate conditions and heterogenic structure of vegetation have provided a favorable environment for the prevalence of butterflies. A total of 247 butterfly species belonging to 31 endemic species and 84 endemic sub-species representing six families, Papilionidae, Lycaenidae, Nymphalidae, Riodinidae, Hesperidae, and Pieridae have been reported by van der Poorten and van der Poorten (2016). Apart from that, several previous investigations focused on butterfly assemblage at different localities such as national parks (Samarasinghe *et al.*, 2013; Bambaradeniya *et al.*, 2001), sanctuaries (Bambaradeniya *et al.*, 2002a; Perera *et al.*, 2005), mangrove estuaries (Bambaradeniya *et al.*, 2002b) and rain forests (Bambaradeniya *et al.*, 2003, Aluthwattha *et al.*, 2009) and forest regeneration sites (Weerakoon & Ranawana, 2021). However, to date, the information on butterfly assemblage in Nuwara Eliya district is scarce in the literature.

Therefore, the present study was undertaken to determine the species diversity, abundance and distribution in a home garden environment located at Hanguranketha region, Nuwara Eliya district.

## 2. MATERIALS AND METHODS

### 2.1 Study Sites

The study was conducted in a home garden (area of 900 m<sup>2</sup>), located at Hanguranketha region (7.1773° N, 80.7760° E) of Nuwara Eliya district (Figure 1). The average temperature of the area is 22±5°C while the average relative humidity is 89±4%. The annual rainfall is around 2000 mm. The elevation is about 1029 m above sea level. Three habitats, a grassland (GL), shrubland (SL) and a disturbed forest patch (DF) were selected for the study (Figure 2). The GL was dominated by plants like *Eleusine indica*, *Setaria barbata* and *Axonopus compressus*. In addition, small herbaceous plants such as, *Urena lobate* and *Sida acuta* were also found there. The SL consisted of *Stachytarpheta urticifolia*, *Lantana camera*, *Ixora coocinea*, *Ochlandra stridula*, *Crotalaria pallida* and *Murraya koenigii*. DF had human-planted trees like *Mangifera indica*, *Psidium guajava*, *Cassia fistula*, *Citrus grandis*, *Punica granatum*, *Sesbania grandiflora*, *Albizia lebbek*, *Elaeocarpus serratus*, *Neolitsea fuscata* and *Annona muricata*. This disturbed forest patch extends to an undisturbed forest reserve.

### 2.2 Sampling Techniques

Sampling was carried out for a period of four months from September to December 2021. At each site, a single 100 m long transect was established. All the butterflies sighted up to 5 m from each side of the transect were identified and counted in the morning from 9.00 a.m. to 9.20 a.m. and in the evening from 3.00 p.m. to 3.20 p.m. in weekly intervals. Butterflies were observed for 20 minutes at each transect. Photographs were also taken for the confirmation of species identification.

Taxonomic keys and field guides were used to identify butterflies to the species level (Heppner and Duckworth, 1981; Gamage, 2014; Wijeyeratne, 2015; Jayasinghe, 2015; van der Poorten, 2016). Shannon-Wiener diversity index (Equation 1) and Shannon evenness (Equation 2) were calculated with respect to each habitat (Magurran, 1988).

$$\text{Equation 1: } H = \Sigma [(pi) \times \ln(pi)]$$

where,

H = Shannon-Weiner Index  
pi = Proportion of total sample represented by species i.

$$\text{Equation 2: } E = \frac{H}{H_{max}}$$

where,

E = Evenness  
H = Shannon-Weiner Index  
H max = lnS  
S = Number of Species

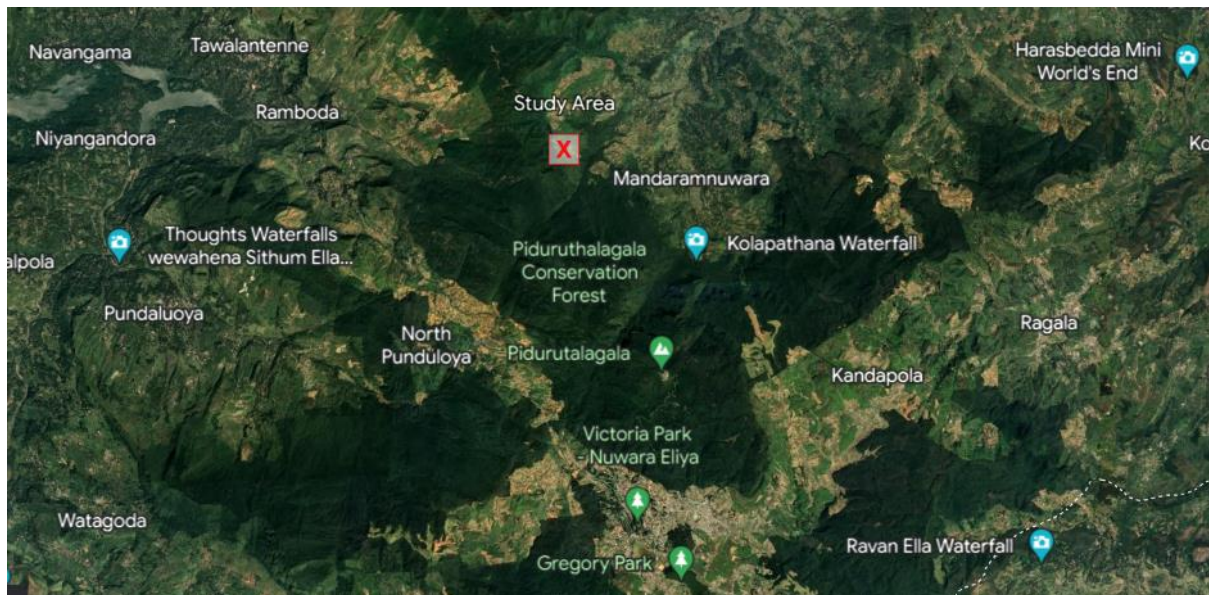
Rainfall and temperature data during the sampling period were obtained from the Department of Meteorology.

### 2.3 Data Analysis

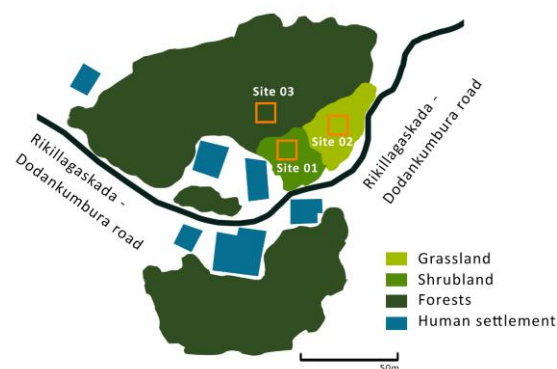
Butterfly abundance among the three habitats were compared using one-way ANOVA after subjecting to square root (X+1) transformation. Mean separation was performed using the Tukey multiple range test. In addition, the abundance of butterflies in the morning and afternoon was compared using the student's t test. SAS statistical package (SAS Institute, 1999) was used for all the analysis at 0.05 significance level.

## 3. RESULTS AND DISCUSSION

In total, 873 individual butterflies belonging to five families, Hesperidae, Lycaenidae, Nymphalidae, Papilionidae and Pieridae, and 32 species were detected (Table 1). Among them, there were 10 endemic sub-species and two

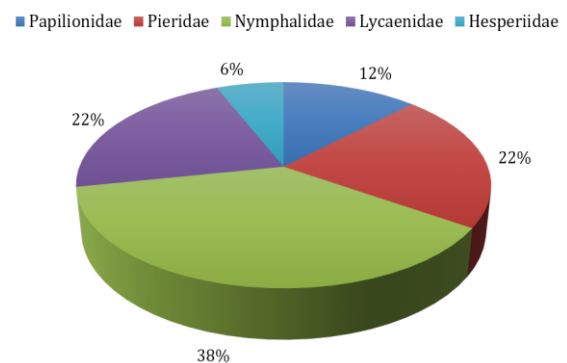


**Figure 1:** Map showing the location of home garden habitat in Hanguranketha, Nuwara Eliya district (Google Earth, 2010)



**Figure 2:** The locations of the three different study sites.

endangered species. Overall, the family Nymphalidae constituted the highest number of species (37.50%). The relative species diversities of Hesperidae, Lycaenidae, Papilionidae and Pieridae were recorded as 06.25%, 21.88%, 12.50% and 21.87%, respectively, irrespective of the habitat type (Figure 3). In the DF and the SL, all the five butterfly families were encountered while in the GL four families were detected excluding Papilionidae. The highest species richness was recorded in the DF (88%) followed by the SL (78%). GL constituted 11 species. Ten common species were recorded in all the habitats whereas 12 species were found in the DF as well as in SL.

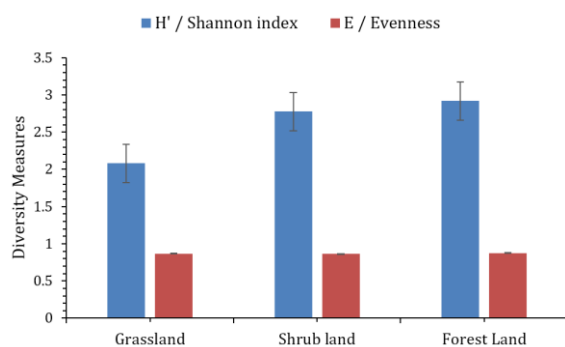


**Figure 3:** Percentage of overall butterfly species belonging to five families.

Some species were found to be restricted to only one habitat, i.e., one, three and six species in GL, SL and DF, respectively.

The highest overall abundance (530 individuals; 61% relative abundance) was detected in Nymphalidae followed by Hesperidae (116 individuals; 13.3%) (Table 01). There was a significant difference in abundance of butterflies ( $F= 12,65$ ;  $df=2, 45$ ;  $P<0.000$ ) among the three habitats. The abundance in the GL was significantly lower ( $P<0.05$ ) compared to DF and the SL; however, no significant difference in abundance ( $P>0.05$ ) was detected between DF and the SL. The highest relative species abundance was shown by *Ypthima ceylonica*

(Family: Nymphalidae) (relative abundance: DF 13.81%; GL: 24.63%; SL 15.43%) followed by *Mycalesis patnia* (Family: Nymphalidae) (relative abundance: DF 13.51%; GL: 20.68%; SL 12.75%). Overall abundance of butterflies recorded in the morning was found to be significantly higher compared to evening (DF:  $t=3.92$ ;  $P<0.0005$ ; GL: 2.64;  $P<0.0129$ ; SL:  $t=3.34$ ;  $P<0.0022$ ;  $df=30$ ). Shannon Weiner diversity index and evenness were estimated as 2.91, 2.08 and 2.78, and 0.876, 0.868 and 0.862 with respect to DF, GL and SL, respectively. (Figure 4).

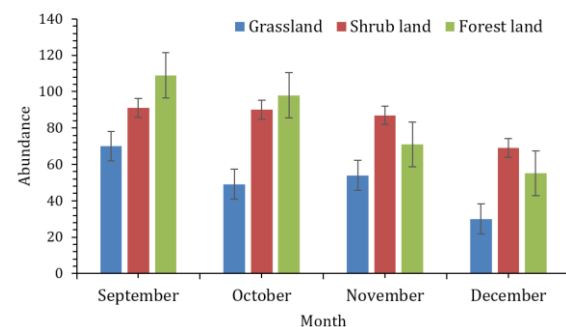


**Figure 4:** Shannon Weiner diversity index and evenness index for butterfly species with respect to three habitat types.

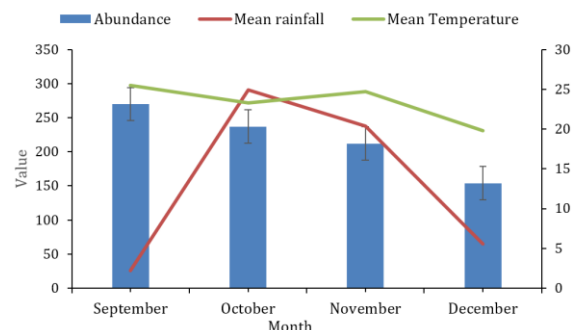
The overall abundance of butterflies over four months varied significantly ( $F=6.87$ ;  $df=3, 12$ ;  $P<0.0025$ ). The abundance in November and December appeared to be significantly lower ( $P<0.05$ ) compared to September and October. However, there was no significant difference in abundance ( $P>0.05$ ) between September and October as well as November and December. Overall abundance in September was 30.92% while the minimum was 17.64% in December. Similar trend was detected in all the three habitats (Figure 5).

In the present study, we were able to encounter 13% of the butterfly species so far recorded in Sri Lanka by van der Poorten and van der Poorten (2016). A previous survey conducted by Kottawa-arachchi *et al.* (2014) in tea plantations of Nuwara Eliya district recorded 43 butterfly species over one year (Kottawa-arachchi *et al.*,

2014). In our study, we encountered 32 species within four months and there were 18 common species in both studies. Moreover, Slater *et al.* (2019) encountered 30 species and 11 unidentified butterflies from Wasgamuwa National Park located in central highlands in Sri Lanka. In this study, 11 butterfly species were reported from Shrubland. In our study, we identified 08 species reported by Slater *et al.* (2019) in the Shrub land at Hanguranketha region.



**Figure 5:** Abundance of butterflies in different months with respect to three habitat types.



**Figure 6:** Fluctuation of butterfly abundance, mean rainfall and mean temperature over four months.

Our findings indicated that the species richness varied with the habitat type in an ascending order of  $<GL<SL<DF$ , corroborating the findings of Peiris *et al.* (2020). However, the abundance of the butterflies in the DF and the SL was found to be more or less similar. Abundance of butterflies mainly depends on the availability of the food resources for adults and larvae (Silva *et al.*, 2021). The high species



**Table 1:** Information on butterfly species recorded at three different habitat types

Habitat	Family	Species	Common Name	Abundance	
Grassland	Hesperiidae	<i>Iambrix minuta</i>	Chestnut Bob	20	
		<i>Suastus gremius</i>	Indian Palm Bob	8	
	Lycaenidae	<i>Castalius rosimon</i>	Common Pierrot	5	
		<i>Jamides bochus</i>	Dark Cerulean	3	
		<i>Jamides celeno</i>	Common Cerulean	21	
		<i>Lampides boeticus</i>	Pea Blue	3	
	Nymphalidae	<i>Mycalesis patnia</i>	Glad Eye Bush Brown	42	
		<i>Mycalesis perseus</i>	Common Bush Brown	20	
		<i>Neptis hylas</i>	Common Sailor	20	
		<i>Ypthima ceylonica</i>	White Four Ring	50	
	Pieridae	<i>Eurema blanda</i>	Three Spot Grass Yellow	11	
	Shrubland	Hesperiidae	<i>Iambrix minuta</i>	Chestnut Bob	33
			<i>Suastus gremius</i>	Indian Palm Bob	16
Lycaenidae		<i>Jamides bochus</i>	Dark Cerulean	6	
		<i>Jamides celeno</i>	Common Cerulean	23	
		<i>Lampides boeticus</i>	Pea Blue	12	
		<i>Loxura atymnus</i>	Yam Fly	4	
		<i>Spalgis epius</i>	Ape Fly	2	
Nymphalidae		<i>Danaus chrysippus</i>	Plain Tiger	4	
		<i>Elymnias singala</i>	Common Palm Fly	5	
		<i>Euploea core</i>	Common Crow	14	
		<i>Junonia atlites</i>	Grey Pansy	2	
		<i>Junonia iphita</i>	Chocolate Soldier	10	
		<i>Lethe drypetis</i>	Tamil Tree Brown	2	
		<i>Mycalesis patnia</i>	Glad Eye Bush Brown	43	
		<i>Mycalesis perseus</i>	Common Bush Brown	32	
		<i>Neptis hylas</i>	Common Sailor	14	
		<i>Orsotriaena medus</i>	Medus Brown	5	
		<i>Parantica aglea</i>	Glassy Tiger	20	
		<i>Ypthima ceylonica</i>	White Four Ring	52	
Papilionidae		<i>Papilio polymnestor</i>	Blue Mormon	3	
		<i>Papilio polytes</i>	Common Mormon	9	
Pieridae		<i>Catopsilia pomona</i>	Lemon emigrant	2	
		<i>Cepora nerissa</i>	Common Gull	3	
		<i>Eurema blanda</i>	Three Spot Grass Yellow	12	
		<i>Leptosia nina</i>	Psyche	9	
Disturbed forest		Hesperiidae	<i>Iambrix minuta</i>	Chestnut Bob	28
			<i>Suastus gremius</i>	Indian Palm Bob	11
		Lycaenidae	<i>Jamides bochus</i>	Dark Cerulean	1
			<i>Jamides celeno</i>	Common Cerulean	14
			<i>Lampides boeticus</i>	Pea Blue	7
			<i>Loxura atymnus</i>	Yam Fly	5
			<i>Talicauda nyseus</i>	Red Pierrot	1
		Nymphalidae	<i>Danaus chrysippus</i>	Plain Tiger	2
	<i>Elymnias singala</i>		Common Palm Fly	7	
	<i>Euploea core</i>		Common Crow	15	
	<i>Junonia atlites</i>		Grey Pansy	5	
	<i>Lethe drypetis</i>		Tamil Tree Brown	7	
	<i>Mycalesis patnia</i>		Glad Eye Bush Brown	45	
	<i>Mycalesis perseus</i>		Common Bush Brown	32	
	<i>Neptis hylas</i>		Common Sailor	11	
	<i>Orsotriaena medus</i>		Medus Brown	6	
	<i>Parantica aglea</i>		Glassy Tiger	19	
	<i>Ypthima ceylonica</i>		White Four Ring	46	
	Papilionidae		<i>Graphium agamemnon</i>	Tailed Jay	10
		<i>Graphium sarpedon</i>	Blue Bottle	5	
		<i>Papilio polymnestor</i>	Blue Mormon	7	
		<i>Papilio polytes</i>	Common Mormon	3	
	Pieridae	<i>Appias albina</i>	Common Albatross	12	
		<i>Catopsilia pomona</i>	Lemon emigrant	9	
		<i>Cepora nerissa</i>	Common Gull	1	
		<i>Delias eucharis</i>	Jezebel	3	
		<i>Eurema blanda</i>	Three Spot Grass Yellow	17	
		<i>Prioneris sita</i>	Painted Sawtooth	4	

richness in the DF could most probably be attributed to the presence of the several fruit crop species. It has been reported that butterfly species of Papilionidae, Nymphalidae, Pieridae and Hesperiidae prefer to visit *Lantana camara* (Silva *et al.*, 2021) because they have high nectar volume and sugar content in flowers. Moreover, previous research indicated that Papilionidae butterflies were frequently observed on red flowers of *Ixora coccinea* (Gandhi and Kumar, 2015). Further, Gandhi and Kumar (2015) reported that *Murraya koenigii*, is a host plant for *Papilio polytes*. All these plant species were found in the SL where we studied, which could contribute to higher abundance of butterflies. Similar to previously reported work, we detected Nymphalidae was the most diverse and dominant family in all the habitat types (Slater *et al.*, 2019; Peiris *et al.*, 2020; Weerakoon and Ranawana, 2021). We found some common species for all the habitats as well as specific species which were restricted to one/two types of habitats.

In general, it was observed that the overall butterfly abundance was slightly dropped with the rainfall and temperature (Figure 06). In addition, the abundance was shown to be lower during November and December which would most probably be associated with the reduced temperature (Silva *et al.*, 2021) compared to September and October 2021. The findings elucidated the butterfly assemblage in previously unexplored region in Nuwara Eliya district and the information gathered in this study is of vital importance towards the conservation of biodiversity.

#### 4. CONCLUSION

The present study shows that the home garden habitats explored in this study were rich with butterflies. However, the butterfly abundance and diversity vary with the sub-habitats investigated. The Family Nymphalidae was recorded as the most common species in all three sub-habitats. The highest number of species and overall abundance were recorded with the Family Nymphalidae.

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